

REFERENCES

- COLLINS, T. AND COLLINS, A. 1976. Puddling action of silver gulls. *The Bird Observer* 535: 46.
- HOBBS, J.N. 1986. Gyrating as a feeding method of the Australian magpie-lark. *Aust. Bird Watcher* 11(7): 238-239.
- HODGKIN, E.P. 1978. An environmental study of the Blackwood River estuary Western Australia 1974-75. *Department of Conservation and Environment Report No. 1*: 1-78.
- MORGAN, G.J. AND BLYTH, J.D. 1987. On the tracks of a natural puzzle. *West. Aust. Nat.* 17(1): 1-3.
- PRENDERGAST, H.D.V. 1983. 'Foot-puddling' by Australian magpie-lark. *Canb. Bird Notes* 8(4): 106-108.
- REYNOLDS, E.G. 1976. The 'foot-pattering' feeding habit of the flame robin. *The Bird Observer* 532: 21.

BREEDING SYSTEMS OF THE WESTERN AUSTRALIAN FLORA III : AIZOACEAE

by G.J. KEIGHERY¹

Department Conservation and Land Management,
W.A. Wildlife Research Centre,
P.O. Box 51, Wanneroo, W.A., 6065

ABSTRACT

Information on the breeding systems of 22 species of the family Aizoaceae is given. Cleistogamy is recorded for *Sarcozona praecox* and *Mesembryanthemum crystallinum*. Self fertility is common. Inbreeding species have been noted in the genera *Gunniopsis*, *Tetragonia* and *Trianthema*.

INTRODUCTION

The family Aizoaceae in Western Australia consists of 46 species (of which 7 are naturalized aliens), many of them being widely distributed throughout the state (Keighery, 1984). Very little information is available on the biology of component species, except for the brief notes on *Carpobrotus* by Black (1969) and the largely taxonomic study on *Gunniopsis* by Chinnock (1983).

MATERIALS AND METHODS

Plants were cultivated, for breeding system studies, from wild collected seed or cuttings. In general those large succulent genera were represented in the study by only a few individuals, but were able to be supplemented by cut material kept in water to observe flower behaviour. During flowering, plants were isolated from insects, and observed. Fortunately in the Aizoaceae anther dehiscence and stigma maturation are readily observable and distinguishable in morphology. If flowers were capable of autogamy (placing its own pollen onto the receptive stigma), and fruits subsequently formed contained seeds, no artificial self pollinations were undertaken. In those cases where autogamy did not occur, artificial self pollinations were made.

Voucher specimens are deposited in Perth and Kings Park.

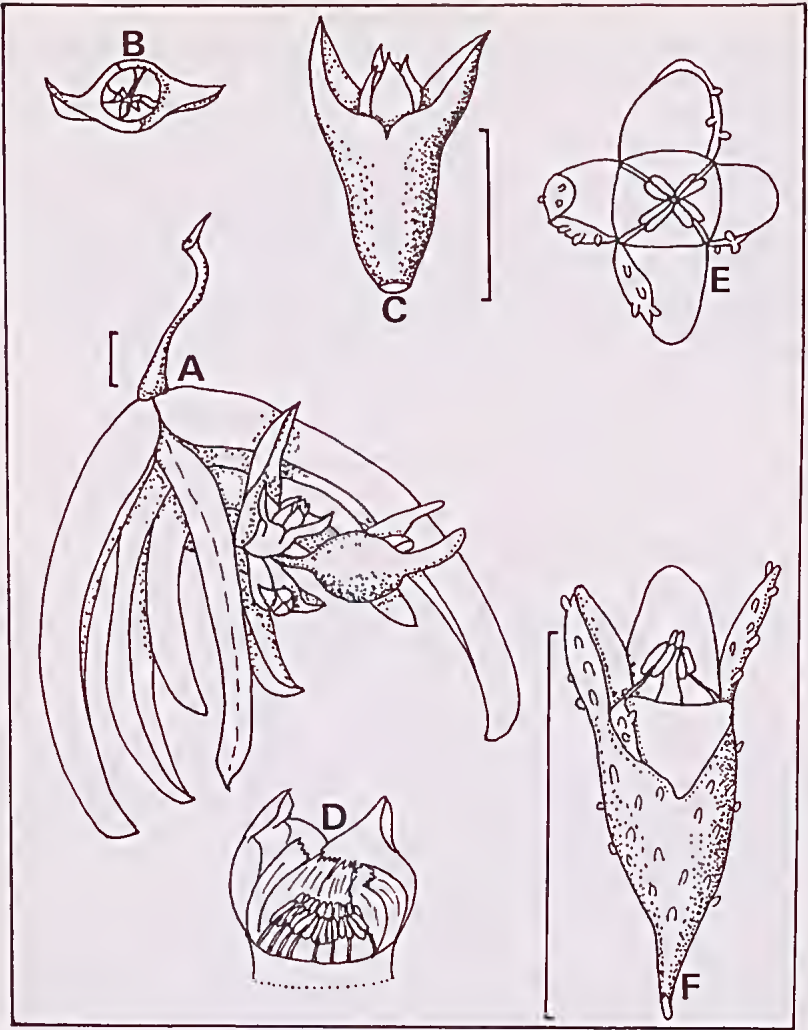


Figure 1: Inbreeding flower forms of Western Australian Aizoaceae.

A-D: *Sarcozona praecox*, scale bar 10cm

E-F: *Tetragonia cristata*, scale bar 5mm

A: Inflorescence*

B: Top view of mature flower

C: Side view of mature flower

D: Detail of mature flower, showing "cap" of petals and stamens (one side removed). x 10.

E: Top view of open flower

F: Side view of open flower

* Plant growing in a pot, normally in the wild this would be in an erect position.

RESULTS

Information on the breeding systems of 22 species of the family Aizoaceae is presented in Table 1. Further notes on each genus follow.

Blake (1969) found that his *Carpobrotus* collections were self fertile, on flower closure. This appears to hold true for collections of *C. edulis*, *C. modestus* and *C. virescens*. However, the white flowered form of *C. rossii* from Quobba appears to be self incompatible, unlike Blake's pink flowered material which originated in South Australia, suggesting regional variation may occur in this species.

Gunniopsis has recently been revised by Chinnock (1983), who noted that the majority of species (11) were highly protandrous (anthers releasing pollen before the stigma matures) outcrossers with brightly coloured flowers, while three species are autogamous annuals with inconspicuous flowers. Chinnock's field observations are borne out by the species studied in Table 1, where the autogamous species, *G. rubra*, has small greenflowers with the four stamens appressed onto the stigma at flower opening. The stamens dehisce onto the stigma at or just before the flower opens. Chinnock suggests that such a system also occurs in *G. propinqua* and *G. septifraga*, and further, that in these species pollination may occur in the closed bud before the flower opens. He also notes that cleistogamy (flowers never open, fertilised by their own pollen within the closed flower) may occur in *G. septifraga*.

Tetragonia contains several large perennial species which are either dioecious or have separate male and female flowers, suggesting a high degree of outbreeding. For example *Tetragonia decumbens* (an introduced species) is highly protandrous and is commonly visited by honey bees at Cottesloe Beach. However, the common and widespread annual species (*T. cristata*, *T. diptera*, *T. eremaea* and *T. tetragonioides*) have small inconspicuous green flowers which self pollinate on flower opening (figure 1, E and F).

In *Trianthema*, the four native species tested (*T. cussackiana*, *T. oxycalyptra*, *T. pilosa* and *T. turgidifolia*) have colourful and protandrous flowers which in several species cannot self pollinate because of the difference in the maturation rates of the stigma and anthers. The naturalized alien, *Trianthema portulacastrum* has small flowers that self pollinate. One native species (*T. triquetra* Willd.) also has small flowers and may also self pollinate, but was not available for testing.

Table 1 — Breeding Systems of Western Australian Aizoaceae.

| Taxon | No. plants used | locality, voucher | floral biology (see key below) | No. self-pollinations |
|---|-----------------|---|--------------------------------|-----------------------|
| <i>*Carpobrotus edulis</i> (L.) L. Bolus | 2 | Cottesloe, G.K. s.n. | Pa/A | — |
| <i>C. modestus</i> S.T. Blake | 1 | Red Gum Spring, Stirling Range, GK 6801 | Pa/A | — |
| <i>C. rossii</i> (Haw.) Schwantes | 1 | Lake Indoon, GK 2440 | Pa/A | — |
| <i>C. virescens</i> (Haw.) Schwantes | 2 | Quobba, GK s.n. | Pa/NA | 27/0 |
| <i>Disphyma crassifolium</i> (L.) L. Bol. | 1 | Cape Leeuwin GK s.n. | Pa/A | — |
| <i>Gunniiopsis calcarea</i> Chinnock | 5 | Lake Austin, Demarz 8037 | Pa/A | — |
| <i>G. quadrifida</i> F. Muell. | 5 | 1km N.W. Caiguna Demarz 9749 | Pa/partially A | 4/4 |
| <i>G. rubra</i> Chinnock | 5 | Cue, Demarz 2775 | Pa/partially A | 4/3 |
| <i>Macarthuria australis</i> Huegel | 5 | 60km E. Mullewa, GK 3318 | Ho/A | — |
| <i>Mesembryanthemum crystallinum</i> L. | 5 | Kings Park, Fairall 85 | Pa/NA | 4/4 |
| | 10 | 31°55'S 122°22'E GK 2937 | Ho/A | — |
| | 10 | Hamelin Pool, Demarz 7566 | Pa/A | — |
| <i>Mollugo molluginea</i> (F. Muell.) Druce | 10 | Wyloo Stn. Demarz 4457 | Pa/A | — |
| <i>Sarcosoma praecox</i> (F. Muell.) S.T. Blake | 2 | near Lake Varley, GK 2396 | cleistogamous Pa/A | — |
| | 2 | 31°57'S 122°22'E, GK 2909 | Pa/A | — |
| <i>Sesuvium portulacastrum</i> L. | 2 | Quobba, Demarz 9907 | Pa/A | — |
| <i>Tetragonia cristata</i> C.A. Gard. ex Prescott | 10 | 1km S. Lake Austin, Demarz 6943 | Ho/A | — |
| <i>T. diptera</i> F. Muell. | 10 | 30km S. Carnarvon, Demarz 9639 | Ho/A | — |
| <i>T. eremaea</i> Ostenf. | 7 | 5km S. Buningonia GK 1959 | Ho/A | — |
| <i>T. tetragonioides</i> (Pallas) Kuntze | 10 | Lake Harris, GK 3134 | Ho/A | — |
| <i>Trianthema cussackiana</i> F. Muell. | 4 | 1km W. Byro, Demarz 3316 | Ho/A | — |
| <i>T. oxycalyptra</i> F. Muell. | 3 | Karratha, GK 6479 | Pa/NA | 7/4 |
| | 2 | 37km S. Bamboo Springs, Demarz 8388 | Pa/NA | 4/4 |
| <i>T. pilosa</i> F. Muell. | 3 | Shay Gap, Demarz 4760 | Pa/A | 4/4 |
| <i>T. turgidifolia</i> F. Muell. | 3 | Point Sampson, J.S. Beard 4560 | Pa/NA | 5/4 |
| <i>*T. portulacastrum</i> L. | 4 | Willara, Demarz 8795 | Pa/A | — |

Flora biology key:

- Pa: Protandrous (anthers mature before stigma)
 Ho: Homogamous (anthers/stigma mature together)
 A: Autogamous
 NA: Not Autogamous

*No. of self pollinators attempted; right hand side
 No. of fruits, containing mature seed set, left hand side

Most of the smaller genera tested (*Disphyma*, *Macarthuria*, *Mollugo* and *Sesuvium*) have colourful flowers which are protandrous and available for pollination but able to self pollination does not occur.

Two small genera deserve further mention. *Mesembryanthemum* (previously *Gasoul*) *crystallinum*, a very common introduced species, contains forms which can occasionally be cleistogamous or which only open a small amount (voucher GK 2937). In other sites plants with larger open flowers are found, e.g. *M. crystallinum* is pollinated by Honey bees on Lipfert Island.

Sarcozona is an endemic Australian genus of two species, confined to the drier regions of southern Australia. One species, *S. praecox* occurs in Western Australia. During 1976 the author collected live plants (from near Lake Varley), which flowered in 1977. Flowering occurred from July to October, the plants producing numerous small cleistogamic flowers (Figure 1, A-D), followed by fruits. The flowers are closed by the four sepals which never open, and a cap of partially fused petals (Figure 1.D.).

Cleistogamy has not previously been reported in *Sarcozona*. Blacke (1969) grew and flowered *Sarcozona bicarinata* from Lock, South Australia and *S. praecox* from Lake Yarle, Ooldea, Lake Eyre, Leigh Creek and Port Augusta (all in South Australia). He found the plants had normal open flowers, and were self fertile. Collections of *S. praecox* from the Western Australian goldfields also have open flowers.

DISCUSSION

A wide variety of breeding systems occur in Western Australia Aizoaceae; cleistogamy has been shown to occur in *Sarcozona praecox*, the introduced *Mesembryanthemum crystallinum*, and is suspected in *Gunnioopsis septifraga*. Inbreeding forms (or species) with inconspicuous flowers that rapidly self pollinate are found in *Gunnioopsis*, *Tetragonia* and *Trianthemum*. However, the majority of species, though mainly self fertile, produce colourful protandrous flowers and are outbreeding.

REFERENCES

- BLAKE, S.T. 1969 "A Revision of *Carpobrotus* and *Sarcozona* in Australia". *Contrib. Queensland Herb.* 7 : 1-65.
CHINNOCK, R.J. 1983 The Australian Genus *Gunnioopsis* Pax (Aizoaceae). *J. Adelaide Bot. Gard.* 6 : 133-179.
KEIGHERY, G.J. (1984 unpublished) Notes on the biology and phytogeography of Western Australian Plants, 42 : Aizoaceae. Kings Park Board, West Perth.

'Previous address:
Kings Park and Botanic Garden, West Perth, W.A., 6005